

Title

The *Microcystis* holobiont: a proposal for the origin of the colonial lifestyle

Abstract

Species of the *Microcystis* genus are the most common bloom-forming toxic cyanobacteria worldwide. They belong to a clade of unicellular cyanobacteria whose ability to reach high biomasses during blooms is linked to the formation of colonies. Colonial lifestyle provides several advantages under stressing conditions of light intensity, ultraviolet light, toxic substances and grazing, allowing *Microcystis* to persist and form dense blooms in a wide range of environmental conditions. The progression from a single-celled organism to multicellularity in *Microcystis* has usually been interpreted as individual phenotypic responses of the cyanobacterial cells to the environment. In this work, we focus on i) the characteristics shared by bacterial biofilms and *Microcystis* colonies; ii) the current knowledge about the colony formation process; iii) the evidence on the existence of quorum sensing (QS) in *Microcystis* and; iv) the information about the colony-associated microbiome; to propose that the morphological, functional and microbiome compositional changes occurring from single cells to colonies are consequence of biological and ecological interactions between the cyanobacterium and the heterotrophic bacteria. These specific and carefully regulated interactions are bi-directional and induce the development of a mucilaginous envelope that will host the heterotrophic community through a biofilm-like mechanism. A conceptual model of emergence and decay of these floating multi-specific biofilms of the *Microcystis* holobiont is presented.